भारतीय मानक
Indian Standard

IS 1206 (Part 3) : 2021

टार और बिटुमन सामग्रियों के लिए परीक्षण पद्धतियाँ — विस्कासिता ज्ञात करना

भाग 3 काइनेमेटिक विस्कासिता

(दूसरा पुनरीक्षण)

Methods for Testing Tar and Bituminous Materials — Determination of Viscosity

Part 3 Kinematic Viscosity

(Second Revision)

ICS 75.140

© BIS 2021

भारतीय मानक ब्यूरो
BUREAU OF INDIAN STANDARDS
मानक भवन, 9 बहादुरशाह ज़फर मार्ग, नई दिल्ली – 110002
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI-110002
www.bis.gov.in   www.standardsbis.in

December 2021   **Price Group 4**

Bitumen, Tar and Related Products Sectional Committee, PCD 06

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards after the draft finalized by the Bitumen, Tar and Related Products Sectional Committee, had been approved by the Petroleum, Coal and Related Product Division Council.

This standard was originally published in 1958 as 'Methods for testing tar and bituminous materials — Determination of viscosity — Kinematic viscosity' and subsequently revised in 1978. 'Methods for testing tar and bituminous materials' was originally published as series of 22 standards in the form of a booklet, as listed below:

IS No.	*Title*
1201 : 2004	Sampling
1202 : 1978	Determination of specific gravity
1203 : 1978	Determination of penetration
1204 : 1978	Determination of residue of specified penetration
1205 : 1978	Determination of softening point
1206 (Part 1) : 1978	Determination of viscosity: Part 1 Industrial viscosity
1206 (Part 2) : 1978	Determination of viscosity: Part 2 Absolute viscosity
1206 (Part 3) : 1978	Determination of viscosity: Part 3 Kinematic viscosity
1207 : 1978	Determination of equiviscous temperature (EVT)
1208 : 1978	Determination of ductility
1209 : 1978	Determination of flash point and fire point
1210 : 1978	Float test
1211 : 1978	Determination of water content dean and stark method
1212 : 1978	Determination of loss on heating
1213 : 1978	Distillation test
1214 : 1978	Determination of matter insoluble in benzene (WITHDRAWN due to toxic nature of benzene)
1215 : 1978	Determination of matter insoluble in toluene
1216 : 1978	Determination of solubility in carbon disulphide trichloroethylene
1217 : 1978	Determination of mineral matter ash
1218 : 1978	Determination of phenols
1219 : 1978	Determination of naphthalene
1220 : 1978	Determination of volatile matter content

However, the Committee responsible for the formulation of standards in the field of bitumen, tar and related products decided to publish these Indian standards separately for each test so as to make it user friendly.

Accordingly, second revision of the standard, has been taken up to formulate individual standard on determination of Kinematic Viscosity. In this second revision of the standard use of suitable thermometers has been permitted in the place of mercury in glass type thermometer mentioned in the earlier version of the standard. The terms Viscosity, Coefficient of Viscosity and Kinematic viscosity have been redefined.

The Composition of the Committee responsible for formulation of this standard is given at Annex A.

In reporting the results of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'.

Indian Standard

METHODS FOR TESTING TAR AND BITUMINOUS MATERIALS — DETERMINATION OF VISCOSITY

PART 3 KINEMATIC VISCOSITY

(Second Revision)

1 SCOPE

This standard (Part 3) covers the method for the determination of kinematic viscosity of paving grade and cut-back bitumen and distillation residues of cut-backs. It is applicable to the materials having a viscosity range of 30-100 000 cSt.

2 REFERENCES

The following standards contain provisions, which through reference in this text, constitute provisions of this draft standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
334 : 2002	Glossary of terms relating to bitumen and tar (*third revision*)

3 TERMINOLOGY

For the purpose of this standard the following definitions and those given in IS 334 shall apply.

3.1 Viscosity of a Newtonian Liquid — The ratio between the applied shear stress and rate of shear is called the coefficient of viscosity. This coefficient is thus a measure of the resistance to flow of the liquid. It is commonly called the viscosity of the liquid. The SI unit of viscosity is 1 Pa · s (1 $N \cdot s/m^2$) and is called a Pascal-second. The CGS unit of viscosity is 1 g/cm·s (1 $dyne \cdot s/cm^2$) and is called a poise (P). 1 Pa.s is equivalent to 10 P.

3.2 Density — It is mass per unit volume, the CGS unit of density is *g/cm*^{3} and the SI unit of density is kg/m^3.

3.3 Kinematic Viscosity of a Newtonian Liquid — The ratio of the viscosity to the density of a liquid. It is a measure of the resistance to flow of a liquid under gravity.

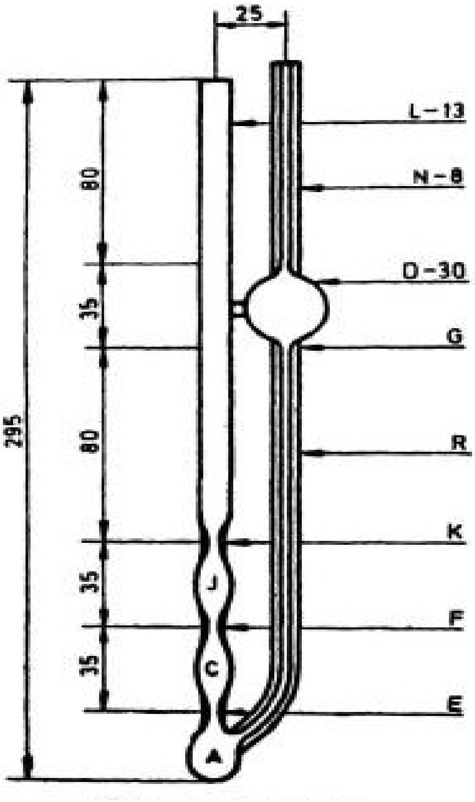
3.4 Newtonian Liquid — A liquid in which the shear stress is directly proportional to the rate of shear. The constant ratio of shear stress to the rate of shear is called the coefficient viscosity of the liquid. If this ratio is not constant then the liquid is non-Newtonian.

4 APPARATUS

4.1 Viscometers — The capillary type of viscometer of borosilicate glass annealed suitable for the test are as given in **4.1.1** and **4.1.2**.

4.1.1 *Cannon-Fenske Viscometer for Opaque Liquids* — Detailed drawings of the reverse-flow Cannon-Fenske viscometer is given in Fig. 1. The size, dimensions, approximate constant. kinematic viscosity range, capillary diameter and bulb volumes shall be as given in Table 1.

4.1.2 BS *U Tube Modified Reverse Flow Viscometer* — The viscometer shall be made of clear borosilicate or other heat resistant glass free from visible defects. All glass tubing used in the construction of a single viscometer shall be of the same composition and the finished instrument shall be thoroughly annealed. The design and dimensions of the viscometer are given in Fig. 2 and Table 2.

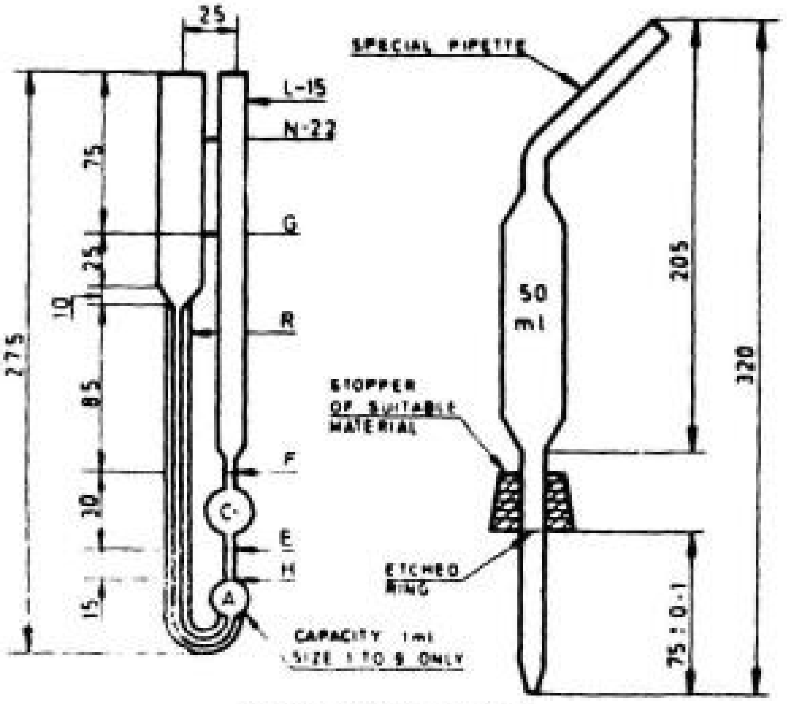


All dimensions in millimetres

Fig. 1 Cannon-Fenske Opaque Viscometer for Opaque and Transparent Liquids

Table 1 Dimensions of Cannon-Fenske Opaque Viscometer for Opaque and Transparent Liquids

Size No.	Approximate Constant	Kinematic Viscometer	Inside Dia of Tube	Inside Dia of Tube	Volume Bulbs A	Volume Bulbs
	cSt/S	RangecSt	R mm (± 2%)	N AND G Tubes E, F & K mm (± 5%)	C and J ml (± 5%)	D ml (± 5%)
150	0.035	2.1 to 35	0.78	3.2	2.1	11
200	0.1	6 to 100	1.02	3.2	2.1	11
300	0.25	15 to 250	1.26	3.4	2.1	11
350	0.5	30 to 500	1.48	3.4	2.1	11
400	1.2	72 to 1 200	1.88	3.4	2.1	11
450	2.5	150 to 2 500	2.20	3.7	2.1	11
500	8	480 to 8 000	3.1	4.0	2.1	11
600	20	1 200 to 20 000	4.00	4.7	2.1	13



All dimensions in millimetres

FIG. 2 BS/IP/RF U-TUBE REVERSE FLOW VISCOMETER FOR OPAQUE LIQUIDS

Table 2 Dimensions and Viscosity Ranges of BS U-Tube, Modified Reverse Flow Viscometer for Opaque Liquid

(*Clause* 4.1.2)

Size No.	**Approximate Constant.**	**Viscosity Range.**	**Inside Dia Of Tube *R* mm**	**Length Of The Tube R**	**Inside Dia *at E.F* and G**	**Bulb C ml**
	cST/s	CST	(+ 2%)	mm	mm	(± 5%)
4	0.1	6-100	1.26	185	3.0-3.3	4.0
5	0.3	18-300	1.64	185	3.0-3.3	4.0
6	1.0	60-1 000	2.24	185	3.0-3.3	4.0
7	3.0	180-3 000	2.93	185	3.3-3.6	4.0
8	10	600-10 000	4.00	185	4.4-4.8	4.0
9	30	1 800-30 000	5.5	185	6.0-6.7	4.0
10	100	6 000-100 000	7.70	210	7.7	4.0
11	300	18 000-300 000	10.00	210	10.00	4.0

4.2 Bath — A suitable bath for immersion of the viscometer so that the liquid reservoir or top of the capillary whichever it; uppermost is at least 20 mm below the upper bath level. Provision shall be there for visibility of the viscometer and the thermometer. The efficiency of the stirring and the balance between heat losses and heat input shall be such that the temperature of the bath medium is maintained at ± 0.1 °C over the entire length of the viscometer.

4.3 Thermometers — The thermometer shall be with least count reading of 0.1 °C and shall be calibrated from competent agency.

4.4 Timing Device — Any timing device, such as stop-watch or stop clock capable of being read up to 0.5 s.

5 CALIBRATION OF VISCOMETER

5.1 Reference Material

Viscosity standard (Certified Viscosity reference standard) may be used for calibration purposes.

5.2 Calibration

Charge the clean dry viscometer by pouring the reference material. Place the charged viscometer in the viscometer bath maintained at calibration temperature within ± 0.1 °C. Allow the charged viscometer to remain in the bath for 30 m to reach the test temperature. Measure to within 0.1 s the time required for the leading edge of the meniscus to pass from the first timing mark to the second.

Calculate the viscometer constant C, as follows:

$$C = V/t$$

where

V = viscosity in centistokes for the standard liquid, and

t = efflux time, in seconds.

5.2.1 The duplicate determination of calibration constant *K* for each bulb shall be within 2 percent of the mean value. The value of Viscometer constants shall be expressed to the nearest 0.1 percent.

5.3 If the viscometer is used at a location other than the calibrating laboratory the constant C should be corrected for the difference in the acceleration of gravity “g” at the two locations as follows:

$$C_2 = g_2/g_1 \times C_1$$

where

C_2 = calibration constant in the testing laboratory,

C_1 = calibration constant in the calibration laboratory,

g_2 = acceleration of gravity at the testing laboratory, and

g_1 = acceleration of gravity at the calibration laboratory.

6 PREPARATION OF SAMPLE

6.1 Procedure for Cut-Back Bitumen and Oil Distillates

Open the sample container and mix the sample thoroughly by stirring for 30 s taking care to avoid entrapped air. For too viscous samples, heat the sealed container in a bath or oven maintained at about 60 °C. Pour immediately 20 ml into a clean dry container having a capacity of about 30 ml and seal the container immediately.

6.2 Procedure for Bitumen-Heat the sample to a temperature not more than 60 °C for tars and pitches and not more than 90 °C for bitumen above the corresponding approximate softening point temperature respectively until it attains pouring consistency. Stir it thoroughly and transfer approximately 20 ml in a 30 ml container. Local over-heating and entrapped air should be avoided.

7 PROCEDURE

7.1 Procedure for Cannon-Fenske Viscometer

7.1.1 To charge the Carmon-Fenske viscometer invert the viscometer and apply suction to the tube *L,* immersing tube *N* in the liquid sample. Draw liquid through tube *N* filling bulbs *D* to fill mark G, wipe excess sample off tube *N* and invert the viscometer to its normal position. Align the viscometer vertically in the bath. Visual observation is sufficient. However, it can be done more accurately and quickly by suspending a plumb bulb in the tube *L.* Allow the viscometer to remain in the constant temperature bath for a sufficient time to ensure that the sample reaches temperature equilibrium. Allow the viscometer to remain in the constant temperature bath a sufficient time to ensure that the sample reaches temperature equilibrium (10 min minimum and 30 min maximum). When the test temperature is reached, remove the stopper in the tubes *N and L* respectively and allow the sample to flow by gravity. Measure to the nearest 0.1 s the time required for the leading edge of the meniscus to pass from timing mark *E* to timing mark *F.* If this efflux time is less than 60 s, select a viscometer of smaller capillary diameter and repeat the operation.

7.1.2 Upon completion of the test, clean the viscometer thoroughly by several rinsing with an appropriate solvent completely miscible with the sample, followed by a completely volatile solvent. Dry the tube by passing a slow stream of filtered dried air through the capillary for 2 min or until last trace of solvent is removed.

7.2 Procedure for BS U-Tube Modified Reverse Flow Viscometer

7.2.1 Mount the BS U-tube viscometer in the constant temperature bath keeping tube *L* vertical. Pour sample through tube *N* to a point just above filling mark G, allow the sample to flow freely through capillary *R,* taking care that the liquid column remains unbroken until the lower mark *H* and then arrest its flow by closing the timing tube with a cork or rubber stopper in tube *L.* Add more liquid, if necessary to bring the upper meniscus slightly above mark G. After allowing the sample to attain bath temperature and any air bubble to rise to the surface (usually about 20-30 min is required), gently loosen the stopper allowing the sample to flow until it is approximately at the lower filling mark *H* and press back the stopper to arrest flow. Remove the excess sample above filling mark G by inserting the special pipette until its cork rests on top of the tube *N* and apply gentle suction until air is drawn through. The upper meniscus shall coincide with mark G. Allow the viscometer to remain in the constant temperature bath for a sufficient time to ensure that the sample reaches temperature equilibrium. It takes about 20 min at 38 °C, 25 min at 100 °C and 30 min at 135 °C. Remove the stopper in the tube N and *L* respectively and allow the sample to flow by gravity. Measure to the nearest 0.1 s the time required for the leading edge of the meniscus to pass from timing mark *E* to timing mark *F.* If this efflux time is less than 60 s select a viscometer of smaller capillary diameter and repeat the operation.

7.2.2 Upon completion of the test, remove the viscometer from the bath and place it in an inverted position in an oven maintained at 135 ± 5 °C until asphalt is drained off thoroughly from the viscometer. Clean the viscometer thoroughly by rinsing several times with an appropriate solvent completely. Dry the tube by passing a slow stream of filtered dry air through the capillary for 2 minutes. Periodically clean the instrument with chromic acid to remove organic deposits. Rinse thoroughly with distilled water and acetone and dry with clean air.

8 CALCULATION

Calculate the kinematic viscosity up to three significant figures with the help of following equation:

$$\text{Kinematic viscosity cSt} = Ct$$

where

C = calibration constant of the viscometer, in centistokes per second, and

t = efflux time, in seconds.

9 REPORT

Report always the test temperature along with the results as follows:

$$\text{Kinematic Viscosity at } 135\ °\text{C} = X,$$

where X = C.t

C = calibration factor

t = time

$1 \text{mm}^2\text{s}^{-1} = 1\text{cSt}$.

10 PRECISION

The duplicate test results should not differ by more than the values given in Table 3.

10.1 Repeatability — The closeness of agreement between independent results obtained with the same method on identical test material, under the same conditions (same operator, same apparatus, same laboratory and after short intervals of time).

10.2 Reproducibility — The closeness of agreement between independent results obtained with the same method on identical test material but under different conditions (different operators, different apparatus, different laboratories and/or after different intervals of time).

Table 3 Precision of Test Results

(*Clause* 10)

Sl No. (1)	Material (2)	Repeatability (3)	Reproducibility (4)
		Percent of Mean	Percent of Mean
i.	Bitumen at 135 °C	1.8	8.8
ii.	Cut back bitumen at 60 °C		
	a) Below 3 000 cSt	1.5	3
	b) 3 000 to 6 000 cSt	2.0	9.9
	c) Above 6 000 cSt	8.9	10.0

ANNEX A

(*Foreword*)

COMMITTEE COMPOSITION

Bitumen,Tar and Related Products Sectional Committee, PCD 06

Organization	*Representative(s)*
CSIR-Central Road Research Institute, New Delhi	Prof Satish Chandra (***Chairman***)
Airports Authority of India, New Delhi	Shri Suprio Gosh Shri Vinod Kumar Sharma (*Alternate*)
Bharat Petroleum Corporation Limited, R & D Centre,Noida	Ms Sonal Maheshwari
Bharat Petroleum Corporation Limited, Mumbai	Shri C. Shanmuganathan
Bharat Petroleum Corporation Limited, Kochi Refinery	Shri Adalazhagan K.
Birla Institute of Technology and Science, Pilani	Shri Sridhar Raju
CSIR-Central Building Research Institute, Roorkee	Ms Rajani Lakhani
CSIR-Central Road Research Institute, New Delhi	Dr Ambica Behl
CSIR-North East Institute of Science and Technology, Jorhat	Dr Shashi D. Baruah Dr B. P. Baruah (*Alternate*)
Central Public Works Department, New Delhi	Shri Divakar Agrawal
Chennai Petroleum Corporation Limited, Chennai	Shri H. Ramakrishnan Dr V. Selvavathi (*Alternate*)
Dilip Buildcon Limited, Bhopal	Shri B. B. Kameswara Rao Shri Anush K. C. (*Alternate*)
Directorate General Border Roads, New Delhi	Shri Umakant Kumar Shri Ashok Kumar (*Alternate*)
Directorate General of Quality Assurance, Ministry of Defence, New Delhi	Shri Vivekanand Shri Anil Kumbhare (*Alternate* I) Shri Sachin Vinayak Zope (*Alternate* II)
Engineer in Chief Branch, New Delhi	Shri O. P. Srivatava Shri R. Jayaprasad (*Alternate*)
G R Infra-Projects Limited, Gurugram	Shri U. C. Gupta
GP Global Asphalt Private Limited, New Delhi	Shri Rajesh Kumar Jain
Highways Research Station, Chennai	Shri T. S. Sundar Shri R. Geetha (*Alternate*)
Hindalco Industries Limited, Mumbai	Shri Harshad Kumar Pandit
Hindustan Colas Private Limited, Mumbai	Shri K. G. Ranganatha Shri T. K. Subhaash (*Alternate*)
Hindustan Petroleum Corporation Limited (HP Green R & D Center), Bengaluru	Shri B. Ravi Shri K. R. Krishna (*Alternate*)
Hindustan Petroleum Corporation Limited, Mumbai	Shri Santosh Dhaku Bhogale
Indian Institute of Petroleum, Dehradun	Shri Manoj Srivastava Dr Kamal Kumar (*Alternate*)
Indian Institute of Technology Bombay, Mumbai	Dr Dharamveer Singh
Indian Institute of Technology Delhi, New Delhi	Dr Aravind Swamy

Organization	*Representative(s)*
Indian Institute of Technology Madras, Chennai	Dr J. Murali Krishnan Dr A. Veeraraghavan (*Alternate*)
Indian Institute of Technology Roorkee, Roorkee	Shri Sham Sundar Ravindranath
Indian Oil Corporation (R & D Centre), Faridabad	Shri Dhanesh Kumar Dr I. Devotta (*Alternate*)
Indian Oil Corporation Limited-Refineries and Pipelines Division, New Delhi	Shri S. B. Lahkar Shri K. Medhi (*Alternate* I) Ms K. Geethashree (*Alternate* II)
Indian Oil Corporation Limited, New Delhi	Shri N. S. Raman
Indian Road Congress, New Delhi	Shri S. K. Nirmal Shri R. V. Patil (*Alternate*)
Indian Oil Total Private Limited, Mumbai	Shri Gaurav Gogne Dr Pankaj Kumar Jain (*Alternate*)
Ministry of Road Transport and Highways, New Delhi	Shri Varun Aggarwal Shri Sanjeev Kumar (*Alternate*)
National Rural Roads Development Agency, New Delhi	Shri B. C. Pradhan
National Test House, Kolkata	Shri Vinay kumar
Nayara Energy Limited, Mumbai	Shri Dhiraj Gondalia Shri Mriganka Tarafdar (*Alternate*)
Om Infracon Private Limited, Guwahati	Shri A. N. Das Shri Manish Bajaj (*Alternate* I) Shri Digambar Deka (*Alternate* II)
Ooms Polymer Modified Bitumen Private Limited, Gurugram	Shri B. R. Tyagi Shri Palash Kathal (*Alternate*)
Shell Bitumen India Private Limited, Gurugram	Shri Nilanjan Sarker
Zydex Industries Limited	Shri Vishal Saluja Shri Himanshu Agarwal (*Alternate* I) Shri Ajay Ranka (*Alternate* II)
In Personal Capacity	Dr P. S. Kandhal
BIS Directorate General	Shrimati Nagamani. T, Scientist 'E' and Head (PCD) [Representing Director General (*Ex-officio*)]

Member Secretary

Shrimati D. Uma
Scientist 'D' (PCD), BIS

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act*, 2016 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Copyright

BIS has the copyright of all its publications. No part of these publications may be reproduced in any form without the prior permission in writing of BIS. This does not preclude the free use, in the course of implementing the standard, of necessary details, such as symbols and sizes, type or grade designations. Enquiries relating to copyright be addressed to the Director (Publications), BIS.

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards: Monthly Additions'.

This Indian Standard has been developed from Doc No.: PCD 06 (16312).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones: 2323 0131, 2323 3375, 2323 9402 *Website*: www.bis.gov.in

Regional Offices: *Telephones*

Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg NEW DELHI 110002 — 2323 7617, 2323 3841

Eastern : 1/14 C.I.T. Scheme VII M, V.I.P. Road, Kankurgachi KOLKATA 700054 — 2337 8499, 2337 8561, 2337 8626, 2337 9120

Northern : Plot No. 4-A, Sector 27-B, Madhya Marg CHANDIGARH 160019 — 265 0206, 265 0290

Southern : C.I.T. Campus, IV Cross Road, CHENNAI 600113 — 2254 1216, 2254 1442, 2254 2519, 2254 2315

Western : Manakalaya, E9 MIDC, Marol, Andheri (East) MUMBAI 400093 — 2832 9295, 2832 7858, 2832 7891, 2832 7892

Branches : AHMEDABAD. BENGALURU. BHOPAL. BHUBANESHWAR. COIMBATORE. DEHRADUN. DURGAPUR. FARIDABAD. GHAZIABAD. GUWAHATI. HYDERABAD. JAIPUR. JAMMU. JAMSHEDPUR. KOCHI. LUCKNOW. NAGPUR. PARWANOO. PATNA. PUNE. RAIPUR. RAJKOT. VISAKHAPATNAM.

Published by BIS, New Delhi